Ohura Water Take:
Ecological Monitoring Report 2021

June 2021

Report Prepared for Ruapehu District Council

Aquanet Consulting Ltd
441 Church Street
Palmerston North

14 Lombard Street
Level 1, Wellington

06 358 6581

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FINAL

Report prepared for Ruapehu District Council by:

Lovisa Ekelund

Aquanet Consulting Limited

Quality Assurance			
Role	Responsibility	Date	Signature
Prepared by	Lovisa Ekelund	19/05/2021	
Approved for issue by:	Mark Heath	24/05/2021	
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EXECUTIVE SUMMARY

1. Ruapehu District Council (RDC) owns and operates the Ohura Water Treatment Plant (WTP). Water is drawn from two sites on the Mangaparare Stream and is treated on site to supply water for the Ohura township. The main abstraction point is directly from the Mangaparare Stream where it intersects Taranui Street.

2. Water permit No. 101866 for the Ohura WTP is expiring on 14th November 2021; therefore, RDC are seeking a renewal of consent and have engaged Aquanet Consulting Ltd to undertake a survey of the macroinvertebrate and fish communities upstream and downstream of the Mangaparare Stream water take.

3. Sampling was undertaken on the 23rd and 24th of March 2021 at two sites on the Mangaparare Stream, upstream and downstream of the water take. The sites were similar in their biophysical characteristics except for stream habitat types: the upstream site had larger riffle areas compared to downstream.

4. The macroinvertebrate groups found at sites upstream and downstream of the Ohura water take were similar, but their relative abundance varied markedly. Most of the population at both sites was comprised of snails. However, mayflies, caddisflies, chironomids, and dipterans were more abundant upstream of the water take compared to downstream.

5. Macroinvertebrate indices were indicative of poor water quality upstream and downstream of the water take.

6. The One Plan target for MCI of 100 for the Upper Ohura water management zone was not met either upstream or downstream of the water take.

7. ASPM scores indicated mild loss of ecological integrity upstream of the water take and severe loss of ecological integrity downstream.

8. Three fish species were identified upstream and downstream of the water take: upland bully, cran's bully, and longfin eel. Crayfish (Koura) were also found at both sites. The number of individuals belonging to each species was considerably higher upstream of the water take indicating there is no fish passage issue due to the water abstraction activity.

9. However, two potential fish passage barriers were identified during sampling: a weir located beneath the culvert adjacent to where the take is located, and the size of the mesh of the water take inlet. Compliance with the minimum standards for fish passage of these structures and possible enhancement actions are discussed.

10. The ecological sampling carried out in the Mangaparare Stream during March 2021 indicate that, while the water abstraction activity is likely is having a considerable effect in the macroinvertebrate communities, the in-stream habitat differences and the presence of stock and horses in the reach between the sampling sites, could also be contributing to the changes observed. The fish survey results indicate that the water take is not limiting fish movement between the upstream and downstream reaches in the Mangaparare Stream. However, the weir associated to the water take and the size of the mesh of the intake itself could be improved to comply with the minimum standards for fish passage.

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1. Introduction

1.1. Background

Ruapehu District Council (RDC) owns and operates the Ohura Water Treatment Plant (WTP). Water is drawn from two sites on the Mangaparare Stream and is treated on site to supply water for the Ohura township. Water permit No. 101866 allows for a maximum of 360m³ of water per day at a maximum rate of 4.2 l/s to be taken from the Mangapare Stream and its artificial tributary under a suite of conditions.

The main abstraction point is directly from the Mangaparare Stream on Taranui Street. The second site is a roadside drain on Hihi Street that is only used when the stream is in flood and water becomes more difficult to treat. The intake structure for the main abstraction point consists of a floating pontoon-mounted pump located immediately upstream of a box culvert under Taranui Street. The pump operates in an artificial pond caused by a significant timber weir on the upstream side of the culvert.

1.2. Hydrology

The Mangaparare Stream is a small tributary of the Mangaroa Stream and generally flows west to east. Before entering the Mangaroa Stream, the Mangaparare Stream is joined by the smaller Mangatawa Stream approximately 500m below the water take. About 40% of the Mangaparare catchment is forested, with the remaining being steep pastured hill country and the flat valley floor.

Estimates of mean daily and monthly flow in the Mangaparare Stream upstream of the Ohura water take were calculated by Hydronet Ltd during March 2021 and a summary is presented below in Table 1.

Table 1: Summary of flow estimates of the Mangaparare Stream upstream of the Ohura water take. All flows in L/s.

Site	Median Flow	Half median flow	20th Flow exceedance %ile	Minimum Flow	Mean annual low flow (MALF)
Mangaparare Stream upstream of the Ohura water take	72	36	225	4	12 L/s

1.3. Aim and Scope

Water permit No. 101866 for the Ohura WTP is expiring on 14th November 2021, therefore RDC are applying for a new consent and have engaged Aquanet Consulting Ltd to undertake a survey of the macroinvertebrate and fish communities on the Mangaparare Stream upstream and downstream of the water take on Taranui Street. The objective of this assessment is to describe the

effects of the take on the macroinvertebrate and communities of the Mangaparare Stream during low flows.

1.4. Structure of the Report

This report is comprised of four sections:

- Section 2 describes the location of the monitoring sites.
- In Section 3 describes the methodology used for site characterisation, macroinvertebrate, and fish sampling on the Mangaparare Stream.
- In Section 4 describes the environmental characteristics of the sites sampled and the results of the macroinvertebrate and fish surveys on the Mangaparare Stream.
- In Section 5 the results of the ecological monitoring surveys are discussed in relation to the potential environmental effects of the activity.

2. Monitoring sites

Two sites on the Mangaparare Stream, upstream and downstream of the water take, were selected for fish monitoring and macroinvertebrate collection. Coordinates for the sites are listed below in Table 2 and their positions mapped in Figure 1. Sites sampled are shown in Plates 1 and 2.

The sites were selected considering access limitations and suitability for electrofishing. The downstream site was located approximately 200m from the water take, and the upstream site was approximately 600m from the water take. The reason for the upstream site being further from the water take was the presence of stock and horses in the stream and the adjacent paddocks in the reach immediately upstream of the water take at the time of sampling. This was considered a safety hazard for electrofishing and setting fishing nets.

Table 2: Sites on the Mangaparare Stream, sampled for macroinvertebrates and fish, March 2021.

Site	Latitude	Longitude
Upstream	38 50 47.90364 S	174 58 15.78761 E
Downstream	38 50 41.23591 S	174 58 47.11028 E

Figure 1: Map showing location of sites sampled on the Mangaparare Stream, upstream and downstream of the Ohura Water Take, March 2021.

Plate 1: Mangaparare Stream, upstream of the water take. Photo taken 23/03/2021.

Plate 2: Mangaparare Stream, downstream of the water take. Photo 23/03/2021.

3. Methods

3.1. Biophysical Characteristics

The biophysical characteristics of each site were measured at the time of macroinvertebrate sample collection. Depth and current velocity were measured at five equidistant (5m) locations along the study reach. Substrate composition was visually assessed and categorised into the groups listed in Table 3. Embeddedness was subjectively assessed as loose, moderate, or tight.

Table 3: Substrate size classes used to assess river substrate composition (Quinn and Hickey 1990)

Bedrock	
Boulders	> 300 mm
Large cobbles	129-300 mm
Small cobbles	65-128 mm
Pebbles	17-64 mm
Gravel	8-16 m

3.2. Macroinvertebrates

Macroinvertebrates are good indicators of water quality as they show a wide range of responses depending on their degree of sensitivity to pollution. For example, some taxa such as Gastropoda and Chironomidae are generally considered to be tolerant of poor-quality water, while others such as Ephemeroptera and Plecoptera prefer good water quality. The macroinvertebrate community at a given site may be considered a result of the prevailing water quality at that site. Consequently, macroinvertebrates are used widely both in New Zealand (Stark 1985, Winterbourn 1999) and overseas (Rosenberg and Resh 1993, Hynes 1994) as indicators of water quality.

Macroinvertebrate samples were collected from the Mangaparare Stream, upstream and downstream of the Ohura water take on the 24th of March following a period of low flows (Appendix A). Since there is no flow gauging site on the Mangaparare Stream, the closest gauging site (Mangaroa at Ohura Town Bridge) was used as a reference.

One composite macroinvertebrate sample consisting of ten sampling efforts (10 x 0.3m^2) was collected at each site using a sweep net and covering different habitat types (riffles, runs, macrophytes, wooden debris). Macroinvertebrate collection was undertaken following Protocols C2 (Soft-bottomed, Semi-quantitative), P3 (Full count with subsampling option) and QC3 (Quality control for full count with subsampling option) from the Ministry for the Environment "Protocols for sampling macroinvertebrates in wadeable streams" (Stark *et al*., 2001*)*.

Macroinvertebrate indices were calculated to assess relationships between macroinvertebrate communities and water quality at each study site.

The Macroinvertebrate Community Index (**MCI**) (Stark 1985) considers the presence of macroinvertebrates based on an assigned score which is dependent on their tolerance to pollution (1= highly tolerant, 10 = highly sensitive). Sensitivity scores for soft-bottomed streams were taken from "Macroinvertebrate metrics for the National Policy Statement for Freshwater Management" (Clapcott *et. al* 2017).

The Quantitative Macroinvertebrate Community Index (**QMCI**) is similar to the MCI, but also takes into account the number of individuals of each species collected. The sampling protocols C2 (Soft-bottomed, Semi-quantitative); however, only allow for a semiquantitative QMCI calculation (**SQMCI**).

Ephemeroptera, Plecoptera and Trichoptera (mayflies, stoneflies and caddisflies) (EPT) consist of insects which are generally sensitive to pollution. The percentage of **EPT taxa** is the proportion of all taxa collected that belong to one of these groups.

The percentage of **EPT individuals** measures the proportion of the individual macroinvertebrates collected that are mayflies, stoneflies and caddisflies.

The **Average Score Per Metric (ASPM)** is a metric aggregation method. ASPM is derived by averaging normalized values of MCI, EPT Taxa and percentage of EPT individuals (Collier, 2008), and indicates the status of the macroinvertebrate communities' ecological integrity in comparison to reference conditions.

Values for the biotic indices discussed above and associated water quality categories are given in Table 4.

Table 4: Interpretation of MCI, QMCI, and ASPM values based on the National Policy Statement for Freshwater Management (NPS-FM, 2020).

Interpretation	MCI	QMCI
Excellent / Clean water	> 130	> 6.5
Good / Mild pollution	110-129	5.5-6.49
Fair / Moderate pollution	90-109	4.5-5.49
Poor / Severe pollution	< 90	< 4.5
Interpretation	ASPM	
High ecological integrity	≥ 0.6	
Mild to moderate loss of ecological integrity	0.4 – 0.59	
Moderate to severe loss of ecological integrity	0.3 - 0.39	
Severe loss of ecological integrity	< 0.3	

The One Plan sets an MCI "State of the Environment" target of 100 for Upper Ohura (Water Management Zone: Whai_4b). These values have been used for comparisons in this report.

3.3. Fish

To accurately survey the fish community of the Mangaparare Stream two different fishing techniques were used: electrofishing and trapping. Every fishing technique is species selective; meaning that some techniques are more effective at capturing certain species than others. For example, electrofishing is more effective in capturing species that like fast flowing habitats while trapping is more effective for cover-seeking species. Using a combination of fishing methods reduces the species bias.

Fishing was carried out following protocols for the backpack electrofishing method and the trapping method (Joy et. al 2013). However, due to the narrowness of the Mangaparare Stream and the small length of accessible and fishable reaches, protocols were reduced to adapt to the site conditions.

Plate 3: Setting of fyke net in the Mangaparare Stream, upstream of the water take, March 2021.

Electrofishing was carried out on the 22nd of March 2021. Three (15m) reaches were fished at each site, upstream and downstream of the water take. Fish were identified and a size class estimated after each fishing effort.

Fish traps (Two fyke nets and four gee minnow traps per site) were set on the evening of the 22nd of March and retrieved in the morning of the 23rd of March. Fish too small to be identified with certainty were included in the count as "unidentified".

Figure 2 and Figure 3 below show the locations of traps and reaches electrofished in the Mangaparare Stream, upstream and downstream of the water take.

Figure 2: Map showing the fishing sites on the Mangaparare Stream, upstream of the water take. Orange lines indicate the 15m reaches electrofished, blue dots indicate locations of fyke nets and yellow dots the locations of gee minnow traps.

Figure 3: Map showing the fishing sites on the Mangaparare Stream, downstream of the water take. Orange lines indicate the 15m reaches electrofished, blue dots indicate locations of fyke nets and yellow dots the locations of gee minnow traps.

4. Results

4.1. Biophysical Characteristics

The upstream and downstream sites were very similar in their physical and chemical characteristics except for stream habitat type. Flow was more variable upstream of the water take with a larger riffle area compared to the downstream site, which was dominated by run and pool habitat.

Table 5: Environmental characteristics of sites monitored on the Mangaparare Stream, upstream and downstream of the Ohura water take, March 2021.

Ohura Water Take	Upstream	Downstream
Date Sampled	23 & 24 March 2021	
Latitude	38 50 47.90364 S	38 50 41.23591 S
Longitude	174 58 15.78761 E	174 58 47.11028 E
Chemical		
Temperature (°C)	13.2	13.7
pH	7.1	7.2
Conductivity (µm)	157.9	154.6
Salinity (ppm)	69.4	68.4
TDS (ppm)	112	110
Physical		
Mean Width (m)	1.74	1.44
Mean Depth (cm)	21.4	45.4
Mean Velocity (m/s)	0.36	0.31
Substrate		
Embeddedness	Loose	Loose
% Boulders (>300mm)	0	0
% Large Cobbles (129-300mm)	0	0
% Small Cobbles (65-128mm)	0	0
% Pebbles (17-64mm)	0	0
% Gravel (8-16mm)	0	0
% Fine Sediment (<8mm)	100	100
Flow Type		
% Pool	30	30
% Run	40	65
% Riffle	30	5
% Rapid	0	0

4.2. Macroinvertebrates

Macroinvertebrate samples were collected from the Mangaparare Stream on the 24th of March following a period of low flows (Appendix A). A complete list of the macroinvertebrate taxa collected is presented in Appendix B.

The macroinvertebrate groups found at sites upstream and downstream of the Ohura water take were similar, but their relative abundance varied markedly (Figure 4). The New Zealand mud snail, *Potamopyrgus* sp. was the most abundant species at both sites comprising 48% of the macroinvertebrate population upstream of the water take and 89% of the population downstream. *Potamopyrgus* sp. is widespread and common in soft-bottomed streams. They can be found in both pristine and polluted environments. However, high densities can be an indication of prolonged low flows (Holomuzki and Biggs, 1999). Mayflies (mostly *Zephlebia* sp.) are considered indicators of good water quality and were more abundant upstream than downstream of the water take. Caddisflies, chironomids and other diptera were also more abundant upstream of the water take.

Macroinvertebrate indices for the sites sampled are shown in Figure 5. While the number of macroinvertebrate taxa was higher upstream of the water take, the number of individuals was higher downstream. Both the percentage of EPT taxa and individuals were higher upstream of the water take.

The MCI and SQMCI scores were indicative of poor water quality at both sites, albeit the downstream scores were lower. The One Plan MCI target of 100 for the Upper Ohura water management zone (Whai_4b) was not met either upstream or downstream of the water take. SQMCI was reduced by 47% downstream of the water take. ASPM scores indicate mild loss of ecological integrity upstream of the water take and severe loss of ecological integrity downstream according to the NPS-FM (2020) attribute state banding.

It is important to note that the assessment of macroinvertebrate indices against the NPS-FM (2020) is to be calculated as a five-year median score. Therefore, this assessment should be considered preliminary and indicative only.

The differences in the macroinvertebrate indices recorded during March 2021 at sites upstream and downstream of the Ohura water take appear to be caused by a combination of factors. While the water abstraction is likely having a considerable effect, it is important to note that that due to access limitations, the upstream site was located approximately 600m upstream of the water take. The area between the sampling site and the water take is surrounded by partially unfenced paddocks (refer to Figure 1). The presence of stock and horses in this area, and the in-stream habitat differences recorded between sites (more riffle areas upstream) could also be contributing to the changes observed in the macroinvertebrate community downstream of the water take.

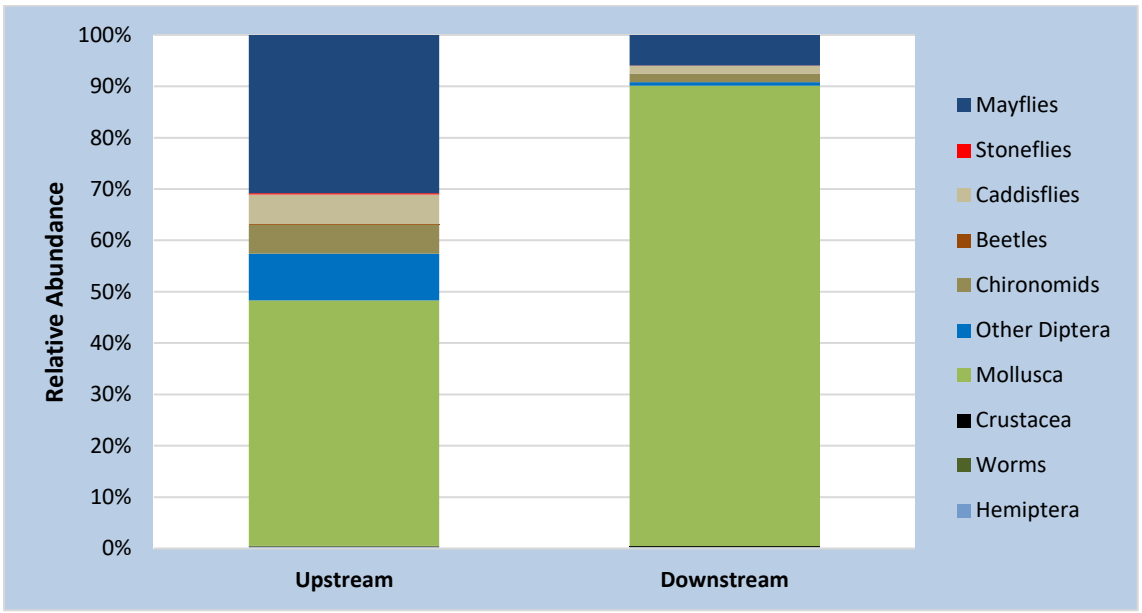

Figure 4: Relative abundance of macroinvertebrate groups sampled from the Mangaparare Stream, upstream and downstream of the Ohura water take, March 2021.

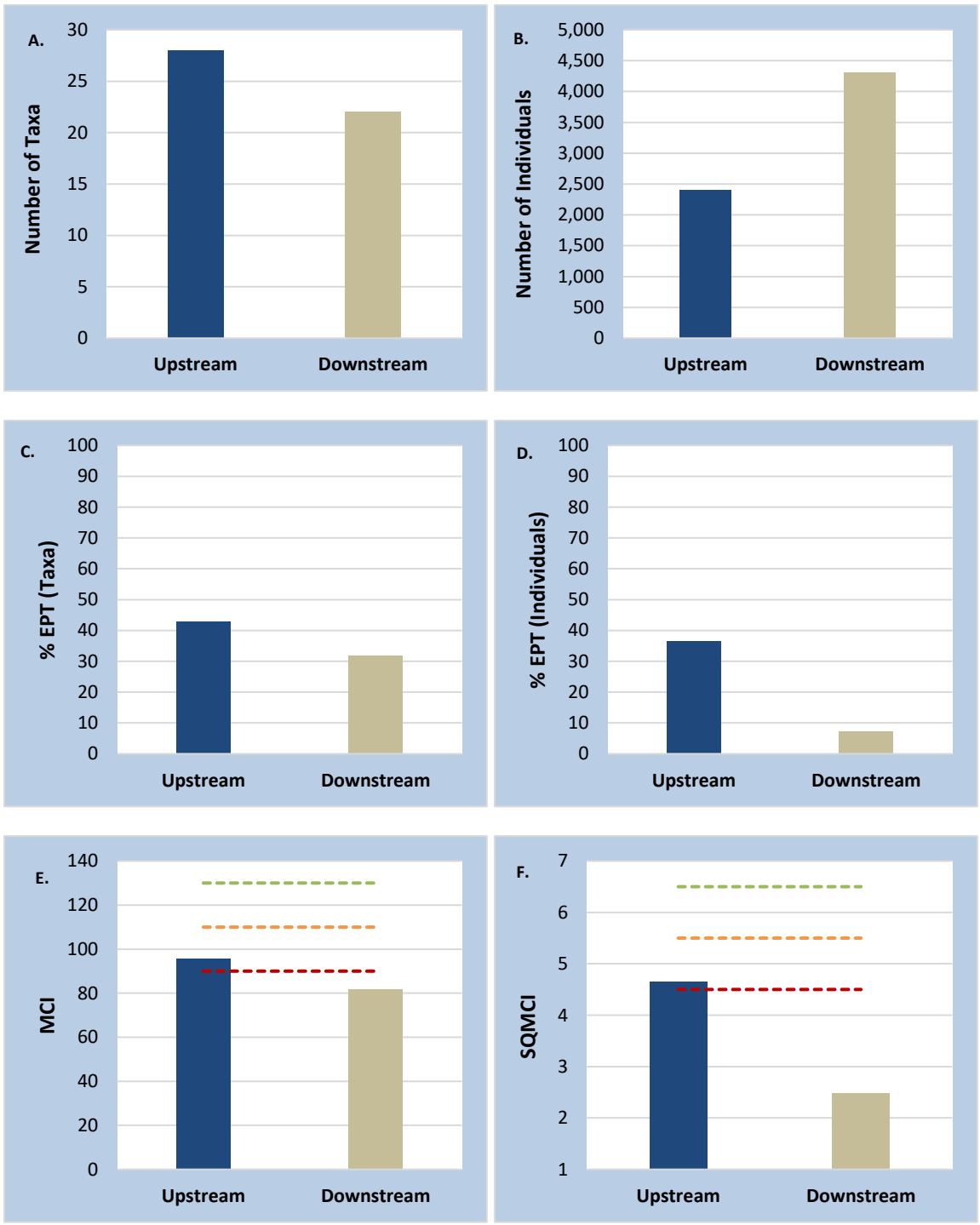

Figure 5: A. Number of Taxa, B. Number of Individuals, C. % EPT Taxa, D. % EPT Individuals, E. MCI, F. SQMCI for sites samples on the Mangaparare Stream, upstream and downstream of the Ohura water take, March 2021. NPS-FM (2020) thresholds indicative of excellent water quality are plotted as a dashed green line, good as an orange line and those of poor water quality as a dashed red line.

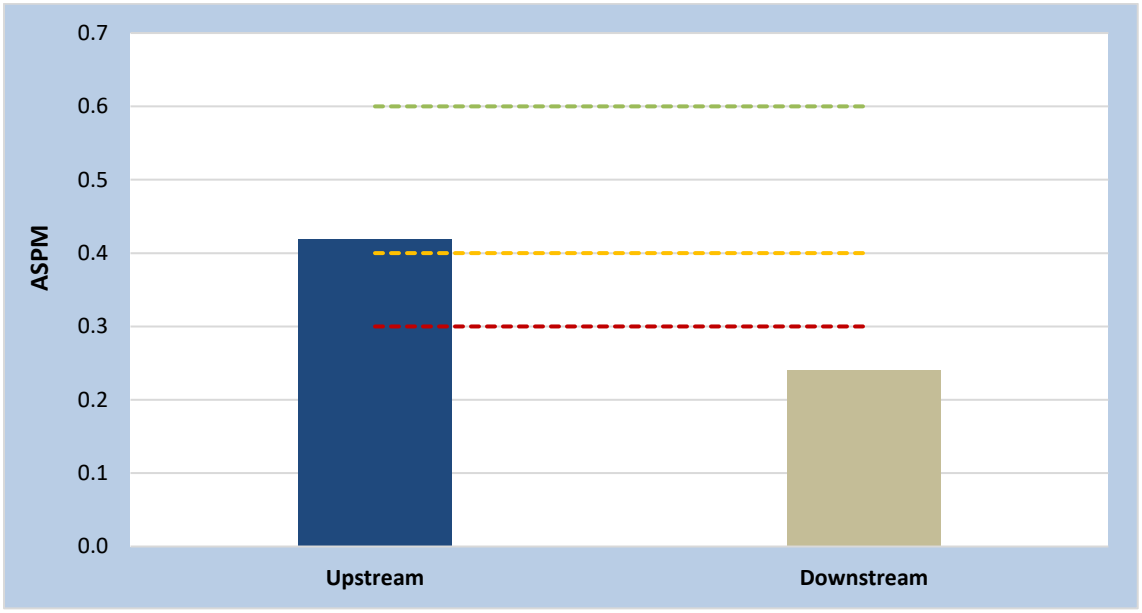

Figure 6: Average Score per Metric (ASPM) for sites sampled on the Mangaparare Stream, upstream and downstream of the Ohura water take, March 2021. NPS-FM (2020) thresholds indicative of high ecological integrity are plotted as a dashed green line, moderate loss of ecological integrity as an orange line and severe loss of ecological integrity as a dashed red line.

4.3. Fish

Results for the fish surveys carried in the Mangaparare Stream upstream and downstream of the Ohura water take during March 2021 are shown in Table 6Table 7, and Figure 7Figure 8. A complete list of all fish caught, and their approximate size is presented in Appendix C.

Overall, three fish species were identified upstream and downstream of the water take: upland bully, cran's bully, and longfin eel. Crayfish (Koura) were also found at both sites. Although the same number of fish species were found upstream and downstream of the Ohura water take, the number of individuals belonging to each species was considerably lower downstream of the water take. Habitat preference might be an explanation for the difference in fish abundance between sites. The upstream site had more flow variability (more fast flowing riffle areas) compared to downstream. However, it is important to note that only one sampling round was carried out and it is difficult to determine with certainty the cause of the difference between sites.

A high proportion of fish in New Zealand are diadromous, spending their life cycles partly in freshwater and partly at sea. Therefore in-stream structures such as weirs, culverts and fords can constitute challenging obstacles for fish migration. Two potential fish passage obstacles were identified during this monitoring round: a weir located beneath the culvert adjacent to where the take is located and the size of the mesh of the water take inlet. The higher number of fish individuals found upstream of the weir and the pump is an indication that fish passage is not a

problem in this stretch of the Mangaparare Stream. However, uncertainties around these fish passage obstacles and potential enhancement actions are addressed below in Section 4.3.1.

Table 6: Results of electrofishing survey on the Mangaparare Stream, upstream and downstream of the Ohura water take (22/03/2021).

Scientific Name	Common Name	Number of Fish	
		Upstream	Downstream
Gobiomorphus breviceps	Upland bully	8	4
Gobiomorphus basalis	Cran's bully	9	3
Gobiomorphus sp.	Unidentified bully	23	1
Anguilla dieffenbachii	Longfin eel	2	0
Anguilla sp.	Unidentified eel	4	3
Paranephrops sp.	Koura	8	1
Total		**54**	**12**

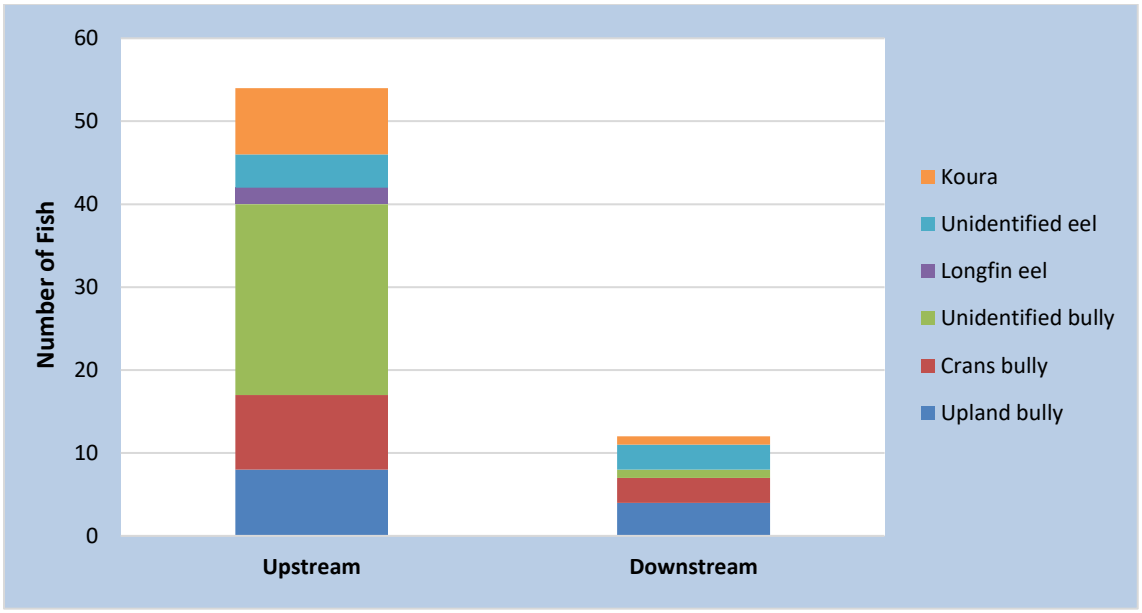

Figure 7: Number of fish identified from the electrofishing survey on the Mangaparare Stream, upstream and downstream of the Ohura water take (22/03/2021)

Table 7: Results of fish trapping survey on the Mangaparare Stream, upstream and downstream of the Ohura water take (23/03/2021).

Scientific Name	Common Name	Number of Fish	
		Upstream	Downstream
Gobiomorphus breviceps	Upland bully	10	5
Gobiomorphus basalis	Cran's bully	32	7
Gobiomorphus sp.	Unidentified bully	42	0
Anguilla dieffenbachii	Longfin eel	3	0
Anguilla sp.	Unidentified eel	1	0
Paranephrops sp.	Koura	2	0
Total		**90**	**12**

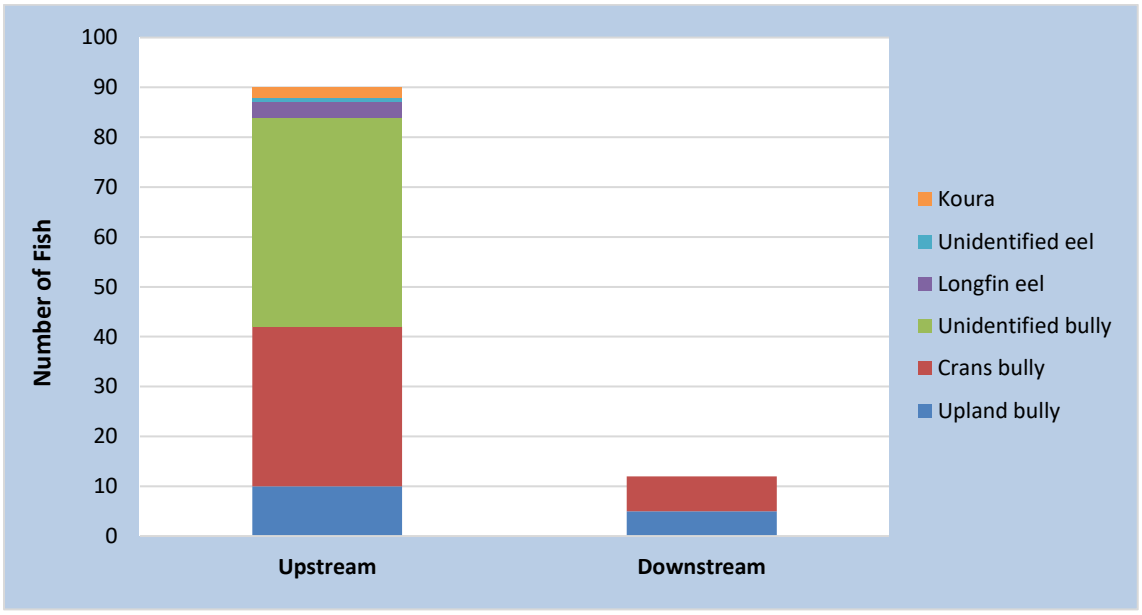

Figure 8: Number of fish identified from the fish trapping survey on the Mangaparare Stream, upstream and downstream of the Ohura water take (23/03/2021)

4.3.1. Fish Passage

Around one third of New Zealand fish species are migratory; as such they need to be able to swim freely between the sea and freshwater habitats to successfully reproduce. Therefore, blocking fish movements between waterways is a significant threat to the survival of fish populations.

Two probable fish passage obstacles associated to the Ohura water take were identified in the Mangaparare Stream during March 2021. The first one is the weir beneath the culvert adjacent to

the water take. The weir allows for ponding where the water intake structure is located and causes a drop in the stream level (approx. 40-50cm high) downstream of the intake (see Plate 4 below).

Although the fish survey carried out in March 2021 does not indicate a fish passage problem in the Mangaparare Stream, the weir does not comply with the minimum design standards for weirs as described in the "*New Zealand Fish Passage Guidelines*" (Franklin et. al 2018). The weir causes a vertical drop and has a smooth concrete surface; as such, the fish would be able to swim downstream but might struggle to get upstream unless flows in the Mangaparare Stream are high.

Vertical drops in instream structures are a common challenge for fish migration. When for practical reasons, the obstacle cannot be removed or replaced, additional structures can be put in place to restore fish passage. Ramp fishways have been widely implemented to overcome vertical barriers less than 2m high. Rock ramp fishways consist of a continuous ramp of rocks on a low gradient that allows for variability in flow. Rock ramp fishways imitate natural stream conditions, with interconnected pathways that allow the fish to rest while swimming upwards. It is important to stress that placing rocks below the weir is not enough to make a suitable ramp, and specific design guidelines should be followed to achieve the desired results. Moreover, climbing ability varies between fish species. Thus, specific designs that cater for the fish communities of a particular stream are recommended. Alternatively, ramps with artificial substrates such as brushes or Miradrain have also been used for the same purpose.

Plate 4: Weir located beneath the culvert adjacent to the Ohura water take in the Mangaparare Stream.

The second is the size of the mesh of the water take itself (see plate 5 below). The mesh size including the frame is 14x4 mm while the inner area/gap is 12x2 mm. The mesh size was measured

with callipers. There is a potential for fish larvae to be "sucked into" the water take due to the mesh size being too large. This might be the case for juvenile bullies for example which can be as little as 5mm long.

There are no national guidelines for fish entrainment, however the "*Fish screening: good practice guidelines for Canterbury*" (Jamieson et. al 2007) were used as a reference for this assessment. According to these guidelines the mesh of the Ohura water take is likely not meeting the minimum requirements to avoided entrainment.

To avoid fish being sucked into the water take, the diagonal length of the mesh should be 3mm or less. The mesh at the Ohura water take measures 12.6mm on the diagonal. Further, the sweep velocity (the velocity of water flowing across the screen that carries the fish away from the screen and back into the main flow) should be greater than the approach velocity (velocity of water going into the screen). Additionally, guidelines stipulate that the approach velocity should be less than 0.12 m/s. The sweep velocity and the approach velocity of the Ohura water take are unknown; therefore, we are unable to confirm that the water intake structure is meeting the requirements to avoid fish entrainment.

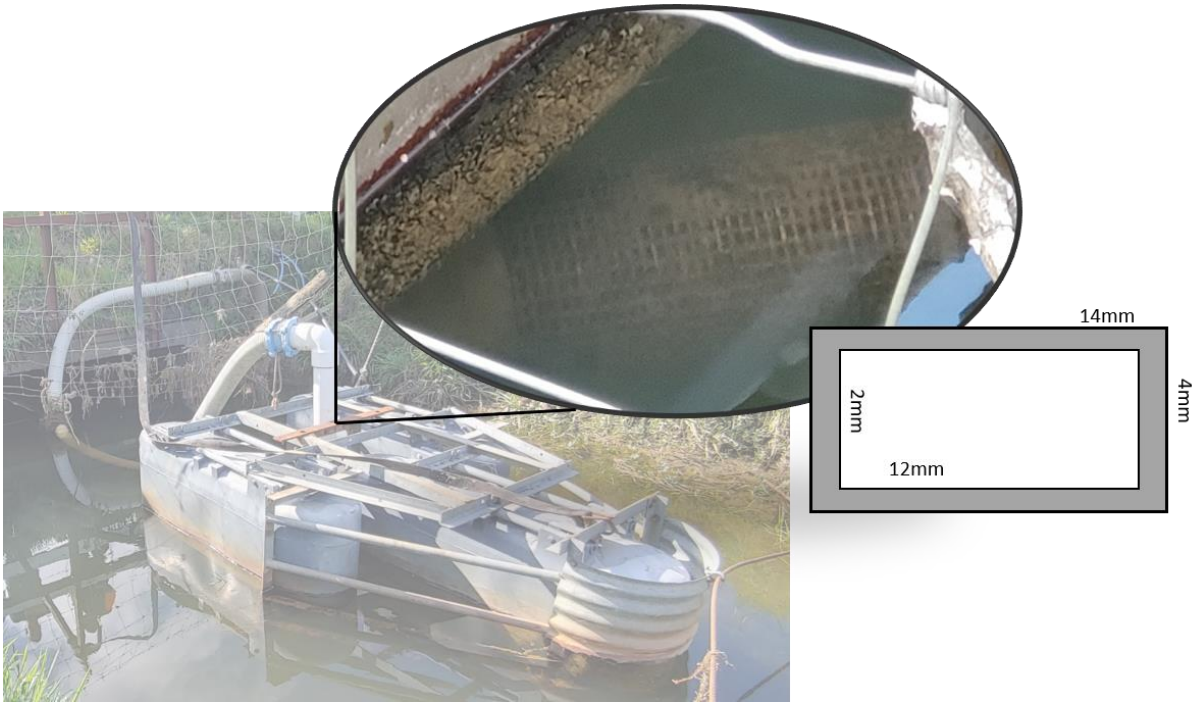

Plate 5: Diagram showing the location and size of the mesh in the Ohura water take system.

5. Discussion and conclusions

Surveys of the macroinvertebrate and fish communities of the Mangaparare Stream, upstream and downstream of the Ohura water take were carried out during March 2021. Differences in the macroinvertebrate community composition recorded during this sampling round at sites upstream and downstream of the Ohura water take appear to be caused by a combination of factors. It is likely that the water abstraction is having a considerable effect. However, the in-stream habitat differences recorded between sites, and the presence of stock and horses in the reach between the sampling sites, could also be contributing to the changes observed.

Results of the fish survey showed that the same number of fish species were present upstream and downstream of the Ohura water take. The number of fish individuals belonging to each species was markedly higher upstream of the water take. These results show that the water take does not appear to be limiting fish movement between the upstream and downstream reaches in the Mangaparare Stream. However, two potential obstacles for fish passage were identified during the March 2021 monitoring round; the weir associated to the water take and the size of the mesh of the intake itself. These structures do not comply with the minimum standards for fish passage and enhancement actions are recommended.

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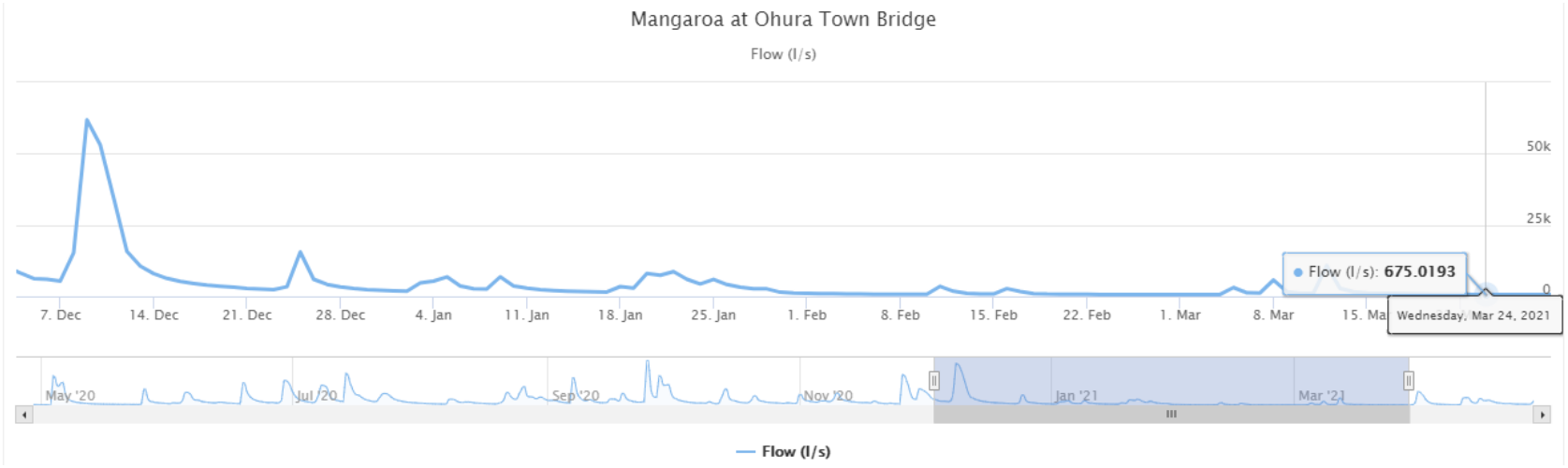
APPENDICES

Appendix A: Flows in the Mangaroa River at Ohura Town Brigde in the weeks previous to sampling.

Retrieved from: https://envirodata.horizons.govt.nz/?siteName=Mangaroa%20at%20Ohura%20Town%20Bridge&collectionName=Flow



Appendix B: Mean density of invertebrates collected in ten sweep net sampling efforts (10 x 0.3m^2) at sites on the Mangaparare Stream, upstream and downstream of the Ohura water take in March 2021.

Taxa	MCI score	Upstream	Downstream
Mayflies			
Deleatidium sp.	5.6	2	2
Neozephlebia sp.	7.6	2	1
Zephlebia sp.	8.8	737	249
Stoneflies			
Megaleptoperla sp.	7.3	1	0
Zelandobius sp.	7.4	4	1
Caddisflies			
Hudsonema sp.	6.5	89	5
Hydrobiosidae Early Instar	6.7	7	0
Hydrobiosis parumbripennis	6.7	3	0
Oecetis sp.	6.8	2	1
Pycnocentria sp.	6.8	5	0
Pycnocentrodes sp.	3.8	4	0
Triplectides sp.	5.7	28	57
Oxyethira sp.	1.2	1	1
Beetles			
Elmidae	7.2	2	0
Hydraenidae	6.7	1	0
Chironomids			
Orthocladiinae	3.2	134	70
Polypedilum sp.	8	1	1
Other Diptera			
Austrosimulium sp.	3.9	209	28
Culicidae	1.2	0	1
Paradixa sp.	8.5	10	0
Crustacea			
Ostracoda	1.9	0	2
Mollusca			
Lymnaeidae	1.2	1	0
Physa sp.	0.1	2	160
Potamopyrgus sp.	2.1	1146	3624
Odonata			
Xanthocnemis sp.	1.2	7	88
Worms			

Platyhelminthes	0.9	3	6
Oligochaetes	3.8	1	1
Other			
Mesovelia sp.	N/A	3	0
Microvelia sp.	4.6	4	2
Sigara sp.	2.4	0	1
Collembola	5.3	0	2
Hydra	1.6	1	5
Number of Taxa		28	22
Number of Individuals		2410	4308
% EPT (Taxa)		42.9	31.8
% EPT (Individuals)		36.7	7.3
MCI		95.6	81.6
QMCI		4.7	2.5
ASPM		0.42	0.24

Appendix C: Number of fish caught through trapping using fyke nets and gee minnow traps (GMT) in the Mangaparare Stream, upstream and downstream of the Ohura water take.

Site	Fish Method	Common Name	Scientific Name	Species Code	Number	Length	
						Min (mm)	Max (mm)
Upstream	GMT 3	Cran's bully	*Gobiomorphus basalis*	gobbas	2	50	75
Upstream	GMT 3	Unidentified bully	*Gobiomorphus* sp	gobiom	1	NA	25
Upstream	GMT 4	No fish caught					
Upstream	Fyke 1	Longfin eel	*Anguilla dieffenbachii*	angdie	1	NA	960
Upstream	Fyke 1	Koura	*Paranephrops* sp	parane	2	NA	NA
Upstream	Fyke 1	Unidentified eel	*Anguilla* sp	anguil	1	NA	250
Upstream	Fyke 1	Upland bully	*Gobiomorphus breviceps*	gobbre	1	NA	25
Upstream	Fyke 1	Upland bully	*Gobiomorphus breviceps*	gobbre	1	25	50
Upstream	Fyke 1	Upland bully	*Gobiomorphus breviceps*	gobbre	3	50	100
Upstream	Fyke 1	Cran's bully	*Gobiomorphus basalis*	gobbas	7	NA	25
Upstream	Fyke 1	Cran's bully	*Gobiomorphus basalis*	gobbas	4	25	50
Upstream	Fyke 1	Cran's bully	*Gobiomorphus basalis*	gobbas	6	50	100
Upstream	Fyke 1	Unidentified bully	*Gobiomorphus* sp	gobiom	29	NA	25
Upstream	GMT 5	Upland bully	*Gobiomorphus breviceps*	gobbre	4	50	100
Upstream	GMT 5	Cran's bully	*Gobiomorphus basalis*	gobbas	3	NA	25
Upstream	GMT 5	Cran's bully	*Gobiomorphus basalis*	gobbas	2	25	50
Upstream	GMT 5	Cran's bully	*Gobiomorphus basalis*	gobbas	3	50	100
Upstream	GMT 5	Unidentified bully	*Gobiomorphus* sp	gobiom	1	NA	25
Upstream	Fyke 2	Longfin eel	*Anguilla dieffenbachii*	angdie	1	NA	1200
Upstream	Fyke 2	Longfin eel	*Anguilla dieffenbachii*	angdie	1	NA	550
Upstream	Fyke 2	Upland bully	*Gobiomorphus breviceps*	gobbre	1	50	100
Upstream	Fyke 2	Cran's bully	*Gobiomorphus basalis*	gobbas	3	NA	25
Upstream	Fyke 2	Cran's bully	*Gobiomorphus basalis*	gobbas	2	50	100
Upstream	Fyke 2	Unidentified bully	*Gobiomorphus* sp	gobiom	11	NA	25
Upstream	GMT 6	No fish caught					
Dowstream	GMT 3	Upland bully	*Gobiomorphus breviceps*	gobbre	1	25	50
Dowstream	GMT 3	Upland bully	*Gobiomorphus breviceps*	gobbre	1	50	100
Dowstream	GMT 3	Cran's bully	*Gobiomorphus basalis*	gobbas	2	25	50
Dowstream	GMT 3	Cran's bully	*Gobiomorphus basalis*	gobbas	1	50	100
Dowstream	GMT 4	No fish caught					
Dowstream	Fyke 1	No fish caught					
Dowstream	GMT 5	Upland bully	*Gobiomorphus breviceps*	gobbre	3	50	100
Dowstream	GMT 5	Cran's bully	*Gobiomorphus basalis*	gobbas	2	25	50
Dowstream	GMT 5	Cran's bully	*Gobiomorphus basalis*	gobbas	1	50	100
Dowstream	GMT 6	Cran's bully	*Gobiomorphus basalis*	gobbas	1	NA	25

Appendix C *(continued):* Number of fish caught using an electro fishing machine (EFM) in the Mangaparare Stream, upstream and downstream of the Ohura water take.

Site	Fish Method	Sub-reach	Common Name	Scientific Name	Species Code	Number	Length	
							Min (mm)	Max (mm)
U/S	EFM	A	Koura	*Paranephrops* sp	parane	3	NA	NA
U/S	EFM	A	Unidentified bully	*Gobiomorphus* sp	gobiom	6	NA	25
U/S	EFM	A	Cran's bully	*Gobiomorphus basalis*	gobbas	2	80	100
U/S	EFM	A	Cran's bully	*Gobiomorphus basalis*	gobbas	1	100	150
U/S	EFM	B	Koura	*Paranephrops* sp	parane	2	NA	NA
U/S	EFM	B	Upland bully	*Gobiomorphus breviceps*	gobbre	3	50	100
U/S	EFM	B	Unidentified bully	*Gobiomorphus* sp	gobiom	9	NA	25
U/S	EFM	B	Cran's bully	*Gobiomorphus basalis*	gobbas	2	80	100
U/S	EFM	B	Longfin eel	*Anguilla dieffenbachii*	angdie	1	NA	404
U/S	EFM	B	Unidentified eel	*Anguilla* sp	anguil	2	NA	20
U/S	EFM	C	Upland bully	*Gobiomorphus breviceps*	gobbre	2	50	100
U/S	EFM	C	Koura	*Paranephrops* sp	parane	3	NA	NA
U/S	EFM	C	Upland bully	*Gobiomorphus breviceps*	gobbre	3	NA	50
U/S	EFM	C	Cran's bully	*Gobiomorphus basalis*	gobbas	3	NA	50
U/S	EFM	C	Unidentified bully	*Gobiomorphus* sp	gobiom	8	NA	25
U/S	EFM	C	Cran's bully	*Gobiomorphus basalis*	gobbas	1	80	100
U/S	EFM	C	Longfin eel	*Anguilla dieffenbachii*	angdie	1	NA	460
U/S	EFM	C	Unidentified eel	*Anguilla* sp	anguil	1	NA	20
U/S	EFM	C	Unidentified eel	*Anguilla* sp	anguil	1	20	30
D/S	EFM	A	Unidentified eel	*Anguilla* sp	anguil	1	25	50
D/S	EFM	A	Upland bully	*Gobiomorphus breviceps*	gobbre	1	50	100
D/S	EFM	B	Koura	*Paranephrops* sp	parane	1		
D/S	EFM	B	Unidentified eel	*Anguilla* sp	anguil	1	800	1000
D/S	EFM	B	Upland bully	*Gobiomorphus breviceps*	gobbre	2	NA	50
D/S	EFM	B	Cran's bully	*Gobiomorphus basalis*	gobbas	2	NA	50
D/S	EFM	C	Upland bully	*Gobiomorphus breviceps*	gobbre	1	50	100
D/S	EFM	C	Cran's bully	*Gobiomorphus basalis*	gobbas	1	NA	50
D/S	EFM	C	Unidentified bully	*Gobiomorphus* sp	gobiom	1	NA	25
D/S	EFM	C	Unidentified eel	*Anguilla* sp	anguil	1	500	800